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## REMOVABLE ROOF ASSEMBLY FOR A MOTOR VEHICLE

### BACKGROUND AND SUMMARY OF THE INVENTION

**[0001]** This application claims the priority of 10254130.2, filed in Germany on November 20, 2002, the disclosure of which is expressly incorporated by reference herein.

**[0002]** The invention relates to a removable roof for a motor vehicle passenger car, which in use covers an opening between a windshield frame and a body frame structure of a body of the passenger car, extending behind vehicle occupant seats, said roof comprising a dimensionally stable material and cooperating by means of a form-lockingly operating fixing system with the windshield frame.

**[0003]** The subject matter of this application is related to commonly assigned applications filed herewith and based on respective German application 10254108.6; 10254130.2; 10254132.9.

**[0004]** On a side facing a windshield frame, a removable roof for motor vehicles known from German Patent Document DE 14 55 743 (Corresponding US 3,476,437) comprises a single form-lockingly operating fixing system. The fixing system is formed by a bearing journal at the roof and a receiving bore at the windshield frame. The bearing journal and the receiving bore are mounted on special consoles which extend away from the roof and from the windshield frame respectively and project into the vehicle occupant compartment.

[0005] German Patent Document DE 94 06 435 relates to a roof which has two roof parts fitted together in a longitudinal center plane and held on the windshield frame solely by means of a locking system. The locking system is equipped with a turning handle which, in a closed position, reaches by means of a nose under a tensioning slope of an interior covering.

[0006] Finally, from German Patent Document DE 41 37 344 A1, a demountable roof for a passenger car is known which extends between an upper member part of a windshield frame and a vehicle body structure behind backrests of vehicle seats. The vehicle body frame structure comprises a rollover bar system which spans a vehicle occupant compartment of the passenger car transversely to the longitudinal direction of the vehicle. The roof consists of a dimensionally stable material and is constructed as a single component, the roof being held in position by means of a fixing system and a locking system on the member part of the windshield frame and on the vehicle body structure respectively.

[0007] It is an object of the invention to create a removable roof for a passenger car which is securely held on a windshield frame by means of a fixing system. However, it should also be reliably ensured that the mounting and the removal of the roof is simple and that the fixing system is distinguished by a good functioning and components which can be implemented in an easy manner.

[0008] According to the invention, this object is achieved by providing a removable roof for a motor vehicle, particularly a passenger car, which in use covers

an opening between a windshield frame and a body frame structure of a body of the passenger car extending behind vehicle occupant seats, said roof comprising a dimensionally stable material and cooperating by means of a form-lockingly operating fixing system with the windshield frame wherein the fixing system of the roof comprises a first fixing device and a second fixing device, which fixing devices are arranged offset with respect to one another in vertical direction of the vehicle by a distance predetermined and are caused to engage by movement of the roof in a driving direction.

**[0009]** Important advantages achieved by means of the invention are that the roof or its roof elements in connection with the first fixing device and the second fixing device can rapidly and appropriately be fixed on the windshield frame in the installed position and vice-versa. In this case the components and devices of the two fixing systems can be implemented by means of acceptable expenditures and, because they are arranged in a targeted manner, assume a largely embedded and lowered position. According to certain preferred embodiments of the invention, the fact that the bearing journal is held in position by means of an elastic device permits the compensation of tolerances and relative movements between the windshield frame and the vehicle body structure which may be represented by a rollover bar. The angular positions of the bearing journal of the second fixing system with respect to the horizontal line as well as of the above-mentioned bearing system with respect to the flange-type roof extension of the first fixing system cause an optimized alignment of the roof or of the roof elements with respect to the

windshield frame and also with respect to the sealing body of the first fixing system according to certain preferred embodiments of the invention. In addition, an excellent sealing action is achieved by means of the sealing sections of the sealing body according to certain preferred embodiments of the invention.

[0010] Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0011] The drawing illustrates an embodiment of the invention which will be explained in detail in the following.

[0012] Figure 1 is a top view of a passenger car with a removable roof constructed according to preferred embodiments of the present invention;

[0013] Figure 2 is a view in the direction of the arrow A of Figure 1;

[0014] Figure 3 is a view of an enlarged detail X of Figure 1;

[0015] Figure 4 is an enlarged sectional view according to Line IV-IV of Figure 3;

[0016] Figure 5 is an enlarged sectional view according to Line V-V of Figure 3;

[0017] Figure 6 is a sectional view according to Line VI-VI of Figure 5.

#### **DETAILED DESCRIPTION OF THE DRAWINGS**

**[0018]** A passenger car 1 comprises an open vehicle body 2 having a windshield frame 3 and a rearward body frame structure 6 extending behind vehicle seats 4, 5, which body frame structure 6 comprises a rollover bar system 8 spanning a vehicle occupant compartment 7. The area between the windshield frame 3 and the rollover bar system 8 is free of supporting member structures which extend in the longitudinal direction B-B of the vehicle and reinforce the vehicle body 2. This means that all bending and torsion moments affecting the vehicle body 2 are to be absorbed by a floor system with its supporting members, which is not shown, so that relative movements between the windshield frame 3 and the rollover bar system 8, which occur, for example, during the driving operation of the passenger car, are taken into account in the case of the connection of a dimensionally stable removable roof 9 with the latter by constructive measures.

**[0019]** The roof 9 comprises a firm plastic material, for example, of a highly stressable type, particularly a fiber-reinforced plastic material - CFK -, covering an opening 10 between the windshield frame and the rollover bar system 8 or rearward body frame structure 6, and is connected with the vehicle body 2 by means of a form-lockingly operating fixing system 11 and a locking system 12. One example of a locking system is indicated in the initially mentioned German Patent Document DE 14 55 743 - Figure 4. Furthermore, the roof 9 comprises two roof elements 13, 14 which are fitted together without connecting elements, thus without hinges, in a longitudinal center plane C-C. Each roof element, for example, 13, interacts by

means of a first fixing device 15 and a second fixing device 16 of the fixing system 11 with the windshield frame and the locking system 12 with the rollover device 8.

[0020] The roof element 13 and the roof element 14 can be stored in a stacked form in a storage space, which is not shown, of the passenger car 1; when the passenger car is in the open condition. For mounting the roof element 13, it is engaged with the fixing devices 15 and 16 by means of a movement directed in the driving direction D - Figure 2 -. In this case, the roof element 13 is slightly lifted, that is, by the extent Da, with respect to the rollover bar system 8. After a defined lowering of the roof element 13, the latter takes up its construction position, and the locking system 12 is operative. The demounting of the roof element 13 takes place in the reverse sequence. Comparable mounting steps are required for the handling of the roof element 14.

[0021] The first fixing device 15 is illustrated in the longitudinal views according to Figures 4 and 5 and is equipped with a flange-type forward roof extension 17 of the roof element 13, which roof extension 17 extends in the longitudinal direction B-B of the vehicle and reaches under an exterior leg wall 18 of an open U-shaped receiving device 19 oriented toward the roof element 13. The receiving device 19 also comprises a web wall 20 as well as an interior leg wall 21, and it is a component of an upper cross-member 22 of the windshield frame 3. With respect to an exterior wall 23 of the roof element 13 extending flush with the exterior leg wall 18, the roof extension 17 is constructed as a step 24.

**[0022]** The second fixing device 16 has a bearing journal 25 which projects into a receiving bore 26, which bearing journal 25 is provided on the roof element 13, and which receiving bore 26 is provided on the transverse member 24 of the windshield frame 3. The receiving bore 26 is worked into a metallic insert 27 which is integrated into the windshield frame 3 consisting, for example, of a fiber-reinforced plastic material, or the cross member 24, in such a manner that the above-mentioned insert 26 is essentially fully embedded or surrounded by boundary walls Bw of the windshield frame 3. Below the bearing journal 25, the cross member 24 is provided with a cushioned member section 28. Adjacent to its free end 29, the bearing journal 25 has a molded-on guiding device 30 of a largest diameter Dg, from which it merge. On the one side, into a shaft 31 with a smaller diameter Dk and, on the other side, tapers off as a conical point.

**[0023]** Figures 5 and 6 illustrate that the bearing journal 25 is fastened to the roof element 13 by means of an elastic device 33 which is provided with two elastic bodies 34 and 35 spaced in the transverse direction E-E of the vehicle and preferably having a circular-cylindrical cross-section which, on the one hand, are held on a cross member 36 of the roof element 13 and, on the other hand, are connected with a plate-type holding member 37 for the bearing journal 26. Each elastic body, for example, elastic body 34, rests by means of a threaded pin 38 in a threaded bore 39 of a metallic insert 40 which is worked into the cross member 36 of the roof element 13 in a fully covered manner. The bearing journal 26 extends in a longitudinal center plane F-F between the elastic bodies 34 and 35 and is held by

means of a threaded pin 41 and a screw nut 42 on the holding member 37, the holding member 37 being fastened by means of screws 43 and 44 on the elastic bodies 34 and 35. In order to accommodate the elastic bodies 34 and 35, possibly also the holding member 37, in a favorable manner in the roof element 13, specifically in a largely sunk manner, the latter is provided with a recess 45. In contrast to the vehicle occupant compartment 7, the elastic bodies 34, 35 and the holding member 37 are covered by means of an interior boundary wall 46 which extends away from the cross member 36 and bounds the recess 45. Two fixing systems 11 provided at a distance from one another in the transverse direction H-H of the vehicle can be mounted on each roof element 13 and 14, in which case each fixing system 11 can be equipped with a first fixing device 15 and a second fixing device 16. The latter are arranged offset in the vertical direction F-F of the vehicle, which is indicated by a distance measurement  $A_m$ .

**[0024]** In order to ensure a targeted function of the first fixing device 15 and of the second fixing device 16, in the longitudinal sectional view according to Figure 4, the bearing journal 26 extends at an acute angle  $\alpha$  (approximately  $15^\circ$  to  $20^\circ$ ) with respect to the horizontal line 47. In this case, the bearing journals 26 of the second fixing device 16 and the forward flange-type roof extension 18 extend at an acute angle  $\beta$  (approximately  $8^\circ$  to  $12^\circ$ ) with respect to one another.

**[0025]** According to Figures 4 and 5, a first sealing section 48 is arranged between the exterior leg wall 19 and the roof extension 18, and a second sealing section 50 is arranged between an interior wall 49 of the roof element 13 and the



interior leg wall 22 of the U-shaped receiving device 20. The first sealing section 48 and the second sealing section 50 are components of a sealing body 51 which extends by means of fitting walls 52, 53, 54 along the exterior leg wall 19, the web wall 21 and the interior leg wall 22 of the receiving device 20. Finally, another important characteristic of the sealing body 51 is a web 55 which extends away from the second sealing section 50 and, together with the above-mentioned sealing section 50, forms a type of groove for the targeted drainage of collected water.

**[0026]** The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.